ON TUMOURS
AND OTHER
SURGICAL DISEASES
BY
JULIUS ALTHAUS, M.D.

J. Johnson

with the author's compliments.

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ON THE

ELECTROLYTIC TREATMENT

OF

TUMOURS

AND OTHER SURGICAL DISEASES.

BEING A PAPER READ BEFORE THE

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BY

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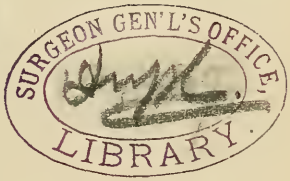

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ON THE

ELECTROLYTIC TREATMENT OF TUMOURS AND OTHER SURGICAL DISEASES.

In bringing my researches on the electrolytic treatment of tumours and other surgical diseases before the Profession, I hardly think that an apology will be necessary for the circumstance that a physician should endeavour to inaugurate a new treatment of such diseases as fall more particularly within the province of the pure surgeon. I trust we are all votaries of catholic medicine, of that one and indivisible science which embraces all the ills mortal man is heir to, whether they are internal or external, and whether mechanical, chemical, or dynamic remedies are required for their removal. There are few surgeons now-a-days who are not fully alive to the advantage to be gained by the administration of constitutional remedies in the treatment of surgical diseases; and I take it that no physician can be really successful in the practice of medicine, who is not well acquainted with surgical pathology and therapeutics. Several instances are on record where surgeons have suggested and carried out valuable improvements in the practice of medicine; and I now express the hope that these researches of a Physician may serve to advance the treatment of a large and important class of surgical diseases.

It is well known that a continuous galvanic current, apart from its physiological action on living bodies, has likewise certain physical and chemical effects, being able, not only to produce a high degree of heat during its transmission through a conducting wire, but also to decompose into their elements any chemical compounds which may be brought under its influence. What s less universally known, is that we may, by modifying the galvanic arrangement and its application in a certain manner, bring about chiefly calorific, or, on the other hand, chiefly chemical effects. The calorific property of the continuous current has, for some considerable time past, been used in surgery, where it is known as the galvanic cautery; while the chemical or electrolytic effects of the current have hitherto been almost entirely neglected, and it is the object of this paper, to introduce the scientific use of these electrolytic effects of galvanism into surgical therapeutics.

Let me, therefore, first explain as concisely as possible what takes place in a galvanic battery which has been properly charged. The consequence of the chemical action of the liquids upon the solids of the battery is, that the natural electricity is decomposed, and active electricity liberated; that is to say, we find a positive current travelling towards the negative electrode, and a negative current travelling towards the positive electrode, both currents having the tendency to neutralise each other. If water or saline solutions be placed into the circuit of the battery, these compounds are decomposed, oxygen and acids being attracted to the positive pole, while hydrogen and alkalies accumulate at the negative pole.

The amount of electricity which is produced within a battery, depends upon the intensity of the electro-motive force, or the surface of the plates of which the battery is composed; but we must carefully distinguish between the

quantity of electricity produced, and the quantity of electricity that is travelling in a certain space of time through a wire, by means of which the poles of the battery are connected. The amount of electricity travelling depends not only upon the intensity of the electromotive force, but also upon the resistance offered to the passage of electricity through conducting bodies, and upon the tension with which it is driven through a conjunctive wire. All bodies through which an electric current is propagated, offer a certain resistance to its passage, and consequently diminish its intensity. Even if the current be transmitted through silver wire, which is the best conductor of electricity, it encounters a certain resistance in its propagation, and loses a certain amount of its intensity. Now we find that, the worse the conductibility of bodies is through which the current travels, or, in other words, the more resistance it encounters in its passage, the greater is the amount of heat produced. This is the reason why platinum wires are used for the galvanic cautery; for, except mercury and lead, which for obvious reasons could not be used for such purposes, platinum is the worst metallic conductor of electricity, which it conducts several million times worse than silver. Silver, copper, gold, and even iron are far better conductors than platinum, and therefore give out far less galvanic heat than the latter metal. Thus, if a platinum wire be interposed between wires of silver, copper, gold or iron, these latter will scarcely show any elevation of temperature, while the platinum wire will be easily rendered incandescent, and be brought to a white heat. For the same reason, the amount of galvanic heat is greater in proportion as the conducting wires offer less volume to the action of the liberated heat. Thus, if we insert a thin platinum wire between two thick platinum wires, and close the circuit, only the thin wire will be

rendered incandescent, because it conducts electricity less well than a thick wire.

The human body is a conductor only by the warm saline solution it contains, and conducts from ten to twenty times better than cold distilled water, after the epidermis has been removed or well moistened; for the epidermis in its dry state offers a very great resistance to the passage of the current. But all liquids conduct much worse than metals; an electric current will more easily pass through a copper wire ten thousand miles in length than through a layer of water one inch in length; and one of the best conducting liquids, with which we are acquainted, viz., a concentrated solution of sulphate of copper, conducts electricity sixteen million times worse than metallic copper. Professor Weber has shown that the human body conducts fifty million times worse than copper; while it appears from the researches of Professor Eckhard, that the muscles are the best conducting tissue of the animal body; that the cartilages, tendons, and nerves conduct electricity about twice, and the bones about nineteen times worse than the muscles. These numbers correspond with the amount of water contained in the animal tissues, and we may put it down as a general principle that, the larger the quantity of water, the better will be the conductibility of the tissues.

The muscles contain	76	per cent.	of	water.	Resistance—1·
The tendons	„ 62	„	„	„	—2·1
The cartilages	„ 62·5	„	„	„	—2.
The nerves	„ 52·5	„	„	„	—2·1
The bones	„ 5	„	„	„	—19.

If, therefore, the human body, or part of it, is placed in the circuit of a galvanic battery, the resistance to the passage of the current will be such that only little electricity

can be collected, unless care be taken to increase in proportion the resistance of the electro-motive apparatus itself, which is done by increasing the number of pairs, that is, by forming a Voltaic pile. The greater the number of pairs, the higher will be the tension, that is, the easier will be the transmission of electricity.

It is evident, from these purely theoretical considerations that no galvanic heat can be produced if the current is applied in such a manner that the whole body or part of the body is placed within the circuit of the battery; as is done for instance, if a needle connected with the negative pole is inserted into the depth of a tumour, while a moistened conductor connected with the positive pole is placed outside on the skin. I have, however, taken the trouble to set this question at rest by actual experiment. I immersed the two poles of the battery, at a certain distance from each other, into animal fluids, thus letting the current travel from the positive to the negative pole, and *vice versâ*, and I then read off the temperature, at the poles as well as in the liquid itself, on a Negretti and Zambra's thermometer, which allows variations of one tenth of a degree of Fahrenheit to be distinctly determined. Now I found that whether I used five, ten, fifteen or twenty cells of the battery, no elevation of temperature took place. The effects of a current administered in this way, are therefore simply electrolytic, and have nothing whatever to do with the galvanic cautery.

I was first led to adopt the electrolytic treatment in consequence of a series of microscopical observations I made some time ago, on the changes which animal structures undergo, under the influence of the chemical action of the continuous galvanic current. As far as I am aware, not a single observation has yet been made by any other observer in this department of microscopical research; and knowing the powerful electrolytic effects of the continuous current, I

expected to arrive at some very curious results in undertaking these investigations.

I have studied the action of the current upon the intimate structure of the skin and cellular tissue, muscular fibres and tendons, cartilages and bones, liver and pancreas, spleen and thyroid body, kidneys, and suprarenal capsules, testicles, breasts and ovaries. The particulars of these observations shall be placed before the profession in a special memoir on the subject. In this place I will only state the general result of these investigations; which is to the effect, that no animal tissue whatsoever can withstand the disintegrating effect of the negative pole, and that the force and rapidity with which this disintegration is brought about, are directly proportional to the electro-motive force which is employed, and to the softness and vascularity of the structures acted upon. Thus ten cells of a battery have a more thorough and rapid effect than five, fifteen more than ten, and so on; while as regards the tissues, those containing most water, such as the muscles, the cellular tissue, the spleen, &c., are more rapidly disintegrated than those which contain less fluid. Bones and teeth withstand the action of the current for a considerable time.

A most curious and novel circumstance forced itself early on my attention; and this was, that the electrolytic action of the negative pole on animal tissues was mainly composed of two different elements; viz., of the mechanical action of the nascent hydrogen, which was, under the microscope, seen to rise in innumerable bubbles, as soon as the circuit was closed, and to force itself, as it were, between the structural elements of the tissues, driving their fibres mechanically asunder; and secondly, of the chemical action of the free alkali (soda and potassa), which, together with the hydrogen, is developed at the negative pole of the battery.

Seeing that such powerful effects were produced at the negative pole, on structures taken out of the body, I was naturally anxious to enquire what would be the effect of the same in the living body. Having procured some *corpora vilia*, viz., frogs and rabbits, I found that the effects were, to a certain extent, identical with those obtained on dead structures; only with this difference, that, in the warm-blooded animal, the action was more rapid and energetic, which is explained by the fact that water at a temperature of 98° conducts electricity better than water at 60°. While, however, the immediate effects of the current were nearly the same in dead and living structures, considerable changes in the nutrition of the parts were observed as proximate and remote sequelæ of such operations in living animals.

It was then observed that a needle connected with the negative pole of the battery could be inserted into, and removed from, the body without causing any loss of blood; that the current used did not appear to give any pain to the animal beyond what was due to the introduction of the needle through the skin; and that the parts operated upon shrank sensibly after the operation, but that there was neither inflammation, suppuration, nor sloughing. If the negative pole was made to act upon bloodvessels, it was found that they were first filled with a foreign body, due to disintegration of the blood, and round which afterwards a slow deposition of lamellated fibrine took place; they were thus changed into solid strings, wherever the current had been made to act.

It appeared fair to conclude from these observations, that the current could be safely and successfully applied to such parts of the body where shrinking and disintegration of tissue, and obliteration of bloodvessels, might be required for surgical purposes. The first case in which I used it in

this manner, was that of a patient under the care of Mr. White Cooper, in July, 1866. Since then I have operated in a considerable number of cases, and in none of them has there been any bad symptom during the progress of the treatment which could have been traced to the application of galvanism.

I now proceed to say a few words about the battery required for the electrolytic treatment, and for which the following qualities appear to be necessary: — It should furnish a large quantity of electricity, and possess considerable electrolytic properties; it should give a constant and reliable current; it should be easy of management, so as to avoid loss of time and trouble in charging and discharging it; it should not easily get out of order; and it should be of such a bulk as to render it possible to carry it easily about. The battery, which is represented on the following page, appears to me to unite all these conditions; it has been constructed for me by Messrs. Weiss, to whom I am obliged for the zeal and ingenuity with which they have carried out my instructions.

Amongst the so-called constant batteries, in which there is little or no variation of current, that constructed on Daniell's principle continues to occupy the foremost rank. Daniell's battery is not so powerful as that constructed by Bunsen or Grove; but this apparent drawback is amply compensated by the high degree of constancy and reliability, which is the characteristic feature of the former arrangement. The original Daniell's battery consists of zinc immersed into salt water or acidulated water, and of copper immersed into a solution of sulphate of copper, there being a diaphragm of porous earth between the two liquids. This arrangement has lately been so modified that no salt or acid is used, and that the zinc is immersed into the solution of sulphate of copper, while the copper is put into ordinary water con-

Fig. 1.

tained in a porous cell, the whole pair being placed in a porcelain vase. This is the arrangement which I have used for several years past with great advantage in the treatment of nervous disorders, and which I described in the "Lancet" for August 15th, 1865. This battery gives an extremely reliable current, but is unfit for transport on account of its great bulk and extremely heavy weight. In the present battery, the porous cell and the porcelain vase have

been altogether dispensed with, the latter being replaced by vulcanite, which is much lighter and quite as durable as porcelain; while the former is compensated for by the copper of the pair being perforated and the holes filled up with leather, which is easily penetrated by moisture. The zinc is then immersed into the solution of sulphate of copper, as usual; but in order to prevent the fluids from splashing when the battery is carried about, they have been intimately mixed with sawdust, so that a dry pile is produced which is quite as effective as the ordinary arrangement. The current furnished by this battery, if carefully charged, continues reliable for about three months. During the whole of that time, no thought need be given to the battery, which is always ready to act and only gradually loses a certain amount of its intensity. Every three months it should be taken to pieces, the zinc cleaned, and a fresh solution of sulphate of copper substituted for the one previously used. The weight of the battery is about 35 pounds, and it is thus sufficiently light to be taken in and out of a patient's room. No acid fumes are developed, and the instrument is by no means unsightly.

The effects of this battery on animal substances are always the same at the negative pole, whatever may be the nature of the conductor used, because metals are not changed by hydrogen or free alkali. At the positive pole, on the other hand, the effects vary according to the chemical nature of the conductor. Thus, for instance, on immersing a gold needle connected with the negative pole, and a steel needle connected with the positive pole, into the white of an egg, a peculiar substance is formed round the negative pole, which at first sight looks like a coagulum or clot, but is in reality no clot at all, but a sort of froth which consists of the particles of albumen mechanically driven asunder by

the nascent hydrogen, and chemically altered by the evolution of free alkali, the presence of which may be shown by its effect on litmus and turmeric paper. At the same time, an entirely different effect is produced at the positive pole, where the steel needle is oxidised, and by the development of sulphuric acid and chlorine, sulphate and chloride of iron are formed, which impart a yellow reddish colour to the albumen, with which they form an organic compound. If the current is applied in this way, no coagulation is produced anywhere. But, if the nature of the positive electrode be changed by substituting a brass or copper wire for the steel needle, immediate coagulation is produced round the positive pole, which is due to the action of the sulphate of copper on albumen. By substituting a steel needle at the negative pole for the gold needle, the same peculiar substance is formed there which was produced round the gold needle. I may remark here that this resembles the foreign body, which may, by electrolysis, be safely deposited in an aneurismal sac, and round which we may expect a slow and gradual deposition of lamellated fibrine to take place.

The disintegrating effect of the negative pole on muscular fibres may be well shown by inserting the negative needle into a small piece of raw beef, where the froth which at once appears on the fibres, denotes the chemical action of the current on muscle. If this is allowed to pass through it for some time, entire destruction of the substance is brought about. Of course, in the living body, such disintegration would be much more rapid, because there the tissues are thoroughly soaked in a saline solution at a temperature of 98°.

I will now say a few words about the instruments which I employ for conveying the galvanic current into the depth of the tissues. The prototype of all is a fine needle of gold or gilt steel, for the negative pole, the circuit being closed by

placing a moistened sponge connected with the positive pole outside on the skin.

Fig. 2.

I always employ different conducting wires for the two poles, in order to be able to tell at once the direction of the current; viz., wires insulated by silk for the negative pole, and such insulated by india rubber for the positive pole.

Most of the other instruments are modifications of the needle. I use conductors from which two, four, six, and eight needles are made to branch off, to suit the requirements of the different cases as they present themselves (Figs. 3, 4, 5, 6). Sometimes circular-shaped conductors are required (Figs. 7 and 8). For the treatment of piles, or ulcers, conductors with a larger surface are better suited; viz., blunt blades (Fig. 9), and round plates of different size (Fig. 10). All these conductors are made of gold or gilt metal, and insulated by ebonite.

Fig. 3.

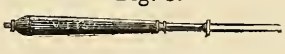

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

I now proceed to consider the pathological conditions in which the electrolytic treatment has been, or may be expected to prove, serviceable. These are—

1st. Tumours.

2nd. Certain diseases of the bloodvessels.

3rd. Serous effusions.

4th. Strictures.

5th. Wounds and Ulcers.

I. Tumours.

In tumours the electrolytic treatment acts in a threefold manner; viz., through mechanical disintegration by the nascent hydrogen, chemical destruction by free alkali, and modification of nutrition by the dynamic effects of the continuous galvanic current on the vaso-motor nerves of the parts brought under its influence.

Nævus.

Although nævus is not commonly dangerous to the patient affected with it, yet it entails a good deal of trouble and annoyance, and being most frequently seated on the scalp and face, gives rise to great disfigurement. Morever, it should be recollected that "nævus is liable to be inflamed by disease or injury, that ulceration may ensue, exposing parts of its substance, and forming irritable and often bleeding sores which rarely heal soundly." (Paget.) It is therefore generally desirable to have a nævus removed.

The very large number and the different kinds of operations which have from time to time been recommended for the cure of nævus, seem to show that hitherto no method has proved entirely satisfactory in its results; for I believe that it is in surgery as it is in physic, viz., that the larger the number of remedies recommended for the cure of a

particular disease, the less is mostly their actual value. The methods generally recommended for nævus are vaccination, excision, injections of alum, perchloride of iron, tannic acid, and ammonia; the ligature, and the écraseur; introduction of probes coated with fused nitrate of silver or chloride of zinc; rubbing in of tartar emetic and croton oil; pressure with pads and elastic bands; the actual cautery; nitric acid; acid nitrate of mercury, chloride of zinc, Vienna paste, &c. Excision is now rarely resorted to for the treatment of nævus, not only on account of the hæmorrhage, which may be very severe, but also because it leaves unsightly scars, and phlebitis and pyæmia may be the consequence. The subcutaneous ligature is now, I believe, generally preferred by surgeons; but it has the disadvantage "that it requires the removal of as much skin as excision does; that it is painful, and followed by tedious sloughing and suppuration, with all the liabilities of open wounds." (Paget.) Caustics are now seldom employed because of the pain to which they give rise, and because it is difficult to limit their effects. Mr. Moore, in his article on "Diseases of the Absorbents," in "Holmes's System of Surgery," incidentally mentions that he had usually found enlargement of the local glands in post-mortem examinations of cases of nævi of the skin; and that in all the fatal cases the patient had died in consequence of some operation on the nævus. I believe, therefore, that a method so safe and so successful as the electrolytic treatment, will prove a positive boon to surgeons in their management of these tumours. I will now relate the details of a case of nævus, which was successfully removed by this proceeding:—

1. *Case of Nœvus of the Eyelid; Operation; Cure.*

In July, 1866, Mr. White Cooper requested me to see with him a lady, aged 28, who had a congenital nævus

of the right lower eyelid, of the size of a small pea, which it was thought desirable to remove. I expressed the opinion that this might be safely done by the electrolytic treatment, without hæmorrhage, and without subsequent inflammation, suppuration, or sloughing; we therefore met on the 23rd of July, in order to perform the operation. As the patient was of a highly sensitive constitution, chloroform was administered by Dr. Allan, of Hyde Park Terrace, the ordinary medical attendant of the lady. As soon as she was fairly under the influence of it, Mr. White Cooper introduced a needle connected with the negative pole of ten cells of the battery into the right half of the tumour, and I closed the circuit by placing a moistened electrode connected with the positive pole to the skin of the neck. The current was then allowed to pass for two minutes, after which the needle was withdrawn. Not a drop of blood was lost, either on introducing, or on withdrawing the needle. The patient recovered well from the chloroform, and said that she felt no pain in the part that had been operated upon, but merely a slight stiffness. The right half of the tumour appeared shrunk and shrivelled up, while the less half had not been altered in any way. This was an interesting circumstance, as it showed that even in so small a tumour as the one described, the action of the current could be exactly limited to that portion of it which was in contact with the needle. We met again on July 26, when the same operation was performed on the other half of the tumour; but this time the patient objected to the use of chloroform, and bore the trifling pain of the galvanism extremely well without it. I have not seen the patient since; but received on October 13th a note from Dr. Allan, in which he expressed himself as follows:—"Mrs. —— is in the country, but last time I heard from her, she said that the nævus had disappeared. A dozen years ago I wished it to be removed; but no one

would do it; and the able and esteemed oculist whom she then consulted, deprecated all interference. At length I persuaded her to have another opinion (that of Mr. White Cooper). The result was your employment of galvanism, with the happy effect of complete obliteration of the evil."

What can be done with nævus can be done with many other tumours by the electrolytic treatment. I subjoin three other cases, the issue of which was equally satisfactory.

2. *Case of Papillary Growth in the Arm-pit; operation; cure.*

A lady, aged 27, consulted me on November 21st, 1866, on account of a small papillary and highly vascular growth which had first appeared in the right axilla since the commencement of 1865, and had somewhat rapidly increased in size during the last few months. It was one-third of an inch long, and one-fourth of an inch wide in its widest part. I introduced a needle connected with fifteen cells of the battery into the base of the tumour, and allowed the current to pass for three minutes. No chloroform or ether spray was used. The current had not acted many seconds when a peculiar change was observed in the tumour, which lost its flesh-colour, and became quite white, as if it had been frozen. When the needle was withdrawn, circulation in the tumour had evidently quite ceased. There was scarcely any pain during the operation, and none at all afterwards, nor was any blood lost.

November 23.—Tumour entirely shrivelled up, looking like a thin brown leaf just adhering to the skin. The operation was therefore not repeated.

December 20.—The eschar fell off about a week after the operation. There is now no sign that there ever was a tumour; no scar nor even redness of the skin being perceptible.

3. *Case of Molluscum of the Right Eyelid; operation; cure.*

A married woman, aged 32, was sent to me by Dr. Tilbury Fox, on November 29th, 1866. She had a very hard globular sebaceous tumour with a broad base, just under the right eyelid; its size was between a large currant and a small hazelnut, and it had a dark point on the summit. The tumour disfigured the face considerably; and it somewhat interfered with the sense of sight, for the patient could not look straight at anything without feeling giddy. As the stratum of corium over the tumour appeared considerably distended, and as I was anxious that no scar should be left after the operation, I only used a current of five cells in this case on three different occasions, viz., on November 29th, and December 1st and 4th.

January 10.—Nearly the whole of the eschar has come off, leaving a soft red surface. At the inner edge a very small piece of tumour still adhering to the skin, for which I applied again a current of five cells for about one minute.

February 5.—No trace is now left of the tumour.

In this case the treatment lasted somewhat longer than usual, because I acted with very low power. The tumour might have been removed by a single operation, but then a scar, which is always an eyesore, might have been the consequence, which I thought it better to avoid, especially as there was no occasion for hurry. I should add that in this case, as in the others, not the slightest bad symptom arose during the progress of the treatment.

That cysts may be successfully treated in the same manner, is shown by the following:—

4. *Case of Hydatids in the muscles of a horse; operation; cure.*

On November 29th, 1866, Mr. F. Mavor, of Park Street, Grosvenor Square, begged me to see a horse, eight years

old, which had a large hydatid tumour in the muscles of the right hip. It had been treated by acupuncture and lancing, and had become somewhat smaller in consequence of the suppuration established in the cysts. There were several abscesses still discharging. Needles connected with ten cells of the battery were introduced into several parts of the tumour, and the operation repeated on December 3. From the time the galvanism was first applied, the tumour shrank rapidly, and the horse is now recovered. At no time was there any inflammation, suppuration, or sloughing from the electrolytic applications, the only symptom observed being that of shrinking.

I have no doubt that the same result would be obtained in

Hydatids of the Human Liver,

an affection for which a safe and quick mode of treatment is still sadly wanting.

Let me add that, although small tumours are more readily removed than large ones, the mere size of a tumour is no impediment to the electrolytic treatment. Large tumours take a longer time to remove than small ones; but the efficacy of the operative proceeding seems to be the same, whatever may be the conformation of the growth. Pediculated tumours are, for obvious reasons, more readily removable than those with a broad base.

Cancer.

A larger experience than I command at present is necessary to decide the question, whether the electrolytic treatment will eventually supersede the methods now in use for the removal of cancer. In consequence of the extreme hardness of scirrhus, the destruction of that form of cancer by electrolysis requires much more time than that of the soft encephaloid form. The plan, however, may be usefully applied

to every variety of cancer, and it seems to be of little consequence whether or not the tumour adheres to the bones; a circumstance which often renders removal by the knife difficult or impossible. I believe that in this most terrible disease the electrolytic method will be found generally useful, not merely by removing the present tumours, but also by so modifying the nutrition of the parts concerned, that no relapse is likely to take place there; and if combined with an energetic constitutional treatment, which should in no case whatever be neglected, it may indirectly help towards the eradication of the cancerous diathesis. It is a curious fact that the peculiar lancinating pains of cancer generally seem to disappear, or at least to diminish considerably, soon after the commencement of the electrolytic treatment, and long before the whole tumour is destroyed.

Lipoma.

Fat being a very imperfect conductor of electricity, lipomas offer more resistance to the electrolytic treatment than other tumours. They may, however, be completely removed by it in course of time. Free alkali being, by the action of the negative pole, developed from the bloodvessels and the connective tissue in which the fat is imbedded, the tumour is gradually changed into an emulsion, which is absorbed into the general circulation.

In leaving this subject, I will mention that slight bleeding may sometimes occur if the tumour is highly vascular, the galvanic power employed very low, and the needle is too rapidly removed; but it can always be stopped at once by again applying the negative pole to the puncture. As a rule, however, there is not the slightest appearance of blood, if the operation is carefully performed.

II. Diseases of Blood-vessels.

Aneurisms have been frequently treated by galvano-puncture; but although some favourable results have thereby been obtained, the number of failures is vastly larger than that of the successes, so that at present the operation of galvano-puncture is, by the best authorities, proclaimed an unsafe and unreliable proceeding. Sir William Fergusson, in his Manual of Surgery, curiously enough ignores it altogether. Professor Pirrie justly remarks that "the operation is founded on the principle of the galvanic current having the power of coagulating the blood; and that this principle is not sound, as stratified fibre is the substance by which we desire to solidify an aneurism, and not coagulated blood; that the proceeding is also very painful, and not unattended with danger, and the results are not encouraging." Mr. Ernest Hart, in his able article on aneurism in Holmes's System of Surgery, says, (Vol. III. p. 432), "It is a radical defect of this procedure that it acts by inducing direct or passive coagulation of blood in the sac. Hence, it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition. Again, it is very capable of exciting inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion and thus give rise to consecutive hæmorrhage. Galvano-puncture appears, then, at present to deserve to rank only as an exceptional expedient. Its claims will have to be considered by the practical surgeon, principally when he is called upon to treat either aneurisms at the root of the neck, or internal aneurism which cannot be reached by digital or mechanical compression, and some forms of varicose and cirroid aneurism seated superficially. The dangers and imperfections of the process must restrict its application even in this limited

field; but as a resource available in cases where neither compression nor ligature can be advantageously applied, it has a sphere of useful action."

M. Broca, and many other eminent foreign surgeons, entirely coincide in this view, and it may be said, therefore, that the proceeding has not established a firm footing in surgery; nor ought we be surprised at this fact, for I think I have already said enough to show that the mode of applying galvano-puncture for aneurism has hitherto been utterly wrong. If anything is well established in the pathology of aneurism, it is the fact, that clots, which have been rapidly produced and made to block up the sac, can be easily discussed or washed away by the current of blood; that they often give rise to consecutive inflammation, suppuration, and gangrene, and are unstable in the highest degree. These clots are red and soft, like currant jelly; they consist of coagulated albumen, fibrine, and blood-globules; while active clots are firm, tough, more or less devoid of colour, and consist merely of lamellated fibrine, resembling so many layers of differently-coloured leather. It is quite true that in a few cases quick coagulation has been followed by permanent consolidation. Such cases have occurred in the practice of M. Pétrequin and other surgeons; but on analysing these observations, we can have no doubt that in the cases which have thus turned out successful, there existed a peculiar condition of the blood highly favourable to the deposition of lamellated fibrine, and that this is so exceptional a circumstance as only to prove the rule, which is, that passive clots are rather prejudicial than otherwise. *Immediate coagulation should therefore be entirely eschewed*, instead of which we should endeavour to obtain a slow deposition of layers of fibrine, whereby the sac may be permanently obliterated. For this purpose it is necessary that circulation should be merely diminished and retarded,

but not altogether interrupted in the sac. As soon as any deposition of fibrine has taken place, this has the tendency to attract fresh fibrine from the blood, whereby its bulk is gradually increased, until the whole sac is filled up. The wall of the aneurism is thus strengthened, and it is enabled to resist the action of the heart, until the time when the cavity is finally obliterated.

That this can be accomplished by placing the negative pole of the battery into the sac, and the positive pole outside, I am convinced from experiments on rabbits, in which I have thus gradually obliterated the femoral artery. But there is also a curious case recorded in a recent treatise on medical electricity, by Dr. Frommhold, of Pesth, which bears out my assertion. This author, whose acquaintance with the physical aspects of electricity is of the most superficial kind, thought to do the right thing, when having a case of aneurism to operate upon, by putting the positive pole into the sac, and the negative pole outside, in order to produce coagulation; but not knowing which was the positive and which the negative pole, as is evident from the details of his description, he used the negative where he meant to use the positive; and the proceeding proved entirely successful. There was no immediate coagulation; but the tumour gradually became harder a few days after the operation, and it seems that the sac was at last completely obliterated.

"Where ignorance is bliss, 'tis folly to be wise."

Dr. Frommhold's case is, for all that, not the less interesting, because it is the first case of aneurism which has been (although accidentally) cured by the negative pole, and thus goes far to prove the correctness of my principle, that it is to the use of this pole that we have to look for the cure of aneurism.

I regret to say that hitherto I have not had the opportunity of operating upon a case of this kind. Some weeks ago a most interesting case of aneurism of the arch of the aorta was brought under my notice by my friend Dr. Cockle; and I went to the Royal Free Hospital, fully prepared to perform the operation. The patient, however, objected to it at the last moment; and I have not heard anything from him since. I shall however use the first opportunity that offers to test the principle in practice; and I have little doubt that my prediction will be fulfilled, viz., that in the electrolytic treatment we shall find the easiest, safest, and most successful way of dealing with aneurismal tumours.

The same considerations apply to the treatment of *varicose veins*, *varicocele*, and *piles*.

III. Serous Effusions.

These effusions may, as a rule, be cured by anything that causes an alteration in the secernent function of the serous membranes. It may therefore be supposed that the continuous galvanic current, which can effect such an alteration mechanically by the hydrogen which is developed, chemically by the free alkali which appears at the negative pole, and dynamically by its special action on the vasomotor nerves, will in course of time prove of the greatest value in the treatment of serous effusions, such as hydrocele, hydrops articuli, hydrothorax, hydropericardium, etc. I have not yet had the opportunity of ascertaining by experience the precise value of this plan in serous effusions; but as several cases of hydrocele have been cured by continental surgeons even with the old method of galvano-puncture, I do not think that my expectations as regards this point are likely to be disappointed.

Pleuritic Effusions and Empyema.

Whatever may be said by the supporters of the operation

of paracentesis of the thorax for pleuritic effusions and empyema, it is very certain that the profession, as a whole, look with considerable distrust upon that proceeding. It cannot be denied that the sudden withdrawal of a large quantity of fluid sometimes induces collapse, and the introduction of air into the pleural cavity is also frequent enough. At the same time, suppuration generally takes place after the operation, and the patient may sink from exhaustion and pyæmia. I may perhaps be allowed to recall here the remarks made ten years ago on this operation by a great master, the late Dr. Addison, who had from the numerous cases seen every year at Guy's Hospital, come to the conclusion that paracentesis of the thorax was one of the worst and most deceiving operations in general practice.* "A serous cavity" (Dr. Addison said) "is almost invariably changed into a cavity pouring out purulent matter by the first operation, and the thick leatherlike false membranes lining the pleura soon make the operation one of great difficulty and danger."

Hydrocephalus and Spina Bifida.

Whether we shall ever feel justified in applying the electrolytic treatment to cases of hydrocephalus, for promoting the absorption of the serous fluid in the head, I do not venture to decide, since in this affection there are almost always other pathological conditions within the cranium which would seem to render any permanent benefit doubtful, if not impossible. I think, however, that the plan would answer very well in certain cases of spina bifida, especially where we have reason to believe that the cord may be absent

* The "Lancet," 1855. Vol. II., Nov. 17.

from the sac, and where the tumour adheres to the bones of the spinal column by means of a pedicle. That the fluid would be absorbed, and the tumours shrink under the influence of the electrolytic treatment, may, I think, be expected with a considerable amount of certainty. I therefore here suggest the idea, hoping it may be carried out at some future time if a suitable opportunity should present itself.

Fig. 11.

IV. Strictures.

Whether in strictures of the urethra and rectum the electrolytic plan will ever be necessary, I must leave to my surgical brethren to decide. There are so many really useful operations for these affections now practised, that I do not think another method is very necessary. It is however different with strictures of the œsophagus, to which I believe the electrolytic plan eminently adapted, as it has hitherto offered insuperable impediments to treatment, and generally led its victims through a terrible series of sufferings to death from starvation. I have, therefore, had an instrument constructed for the treatment of such cases (Fig. 11). This is an œsophagus sound, perforated in the middle so as to leave a canal for a conducting wire, which ends in a needle. It may be introduced closed, and by a simple contrivance the hidden needle may be brought out and applied to any point upon which we may be desirous to act.

Figs. 12 and 13 represent instruments which may be used in the same manner for strictures of the urethra and rectum.

Fig. 12.

Fig. 13.

V. Wounds and Ulcers.

In wounds and ulcers which are slow to heal, and where the secretion is of an unsatisfactory character, the application of the negative pole is usually followed by excellent results. I have in several instances seen a rapid improvement in the aspect, and a kind healing of ulcers, which had existed for a long time, and where gangrene had already supervened, follow a few applications of the current. An additional advantage in such cases is, that scars which are developed under the influence of the negative pole, have little or no tendency to contract, and resemble healthy skin more than other scars. I have not yet had the opportunity of treating hospital gangrene in this manner; but from what I have seen in other forms of gangrene, I feel justified in strongly recommending the use of the negative pole to surgical practitioners in their treatment of that most unmanageable affection. The best conductors for such cases are round metal plates. (Fig. 10, p. 14.) Fistulæ and sinuses may also be healed by their application.

I will now briefly say what I believe to be the advan-

tages of the method I have described, over many other surgical proceedings:—It causes little or no bleeding during or after the operation. There is no shock to the system. It causes very little pain, so that, as a rule, no chloroform or ether spray is necessary. No bandaging whatever is required, except for open wounds and ulcers. No inflammation, suppuration, or sloughing, are apt to follow, and the patients may, as a rule, during the progress of the treatment, pursue their usual avocations, not being obliged to stay in bed or even in doors. If the electrolytic treatment is not as quick as the knife, it is, on the other hand, exempt from the dangers which may follow all cutting operations; and it will, on this account, be probably preferred in many cases where the knife is inapplicable or objected to, where less safe proceedings have hitherto been employed, and where the delay of a few days or weeks appears to be of little consequence.

In concluding this paper, I would urge my surgical brethren to give their attention to the principles I have proposed, and a trial, in suitable cases, to the plan of treatment I have recommended, being convinced that, as the method rests on sound physiological bases, and has already been tested with satisfactory results in practice, it must, from the peculiar advantages inherent to it, prove extensively useful in the treatment of a large and important class of surgical diseases.